

tinued falling in Newfoundland, New Brunswick, and Nova Scotia, until the 15th, p. m. The history of this low area belongs to the North Atlantic meteorology.

VII.—Although this area is charted as beginning on the 23d, p. m., in Virginia, yet there was a previous history that may plausibly, at some time hereafter, be shown to have had an intimate bearing upon its development. On the 18th pressure was low from the Gulf of California to Washington, and on the 19th a special depression appeared in British Columbia; this extended southeastward, diffusing itself over a large area without filling up; on the 21st, a. m., it was central in Wyoming, and on the 22d, p. m., a depression appeared extending from Arizona to Texas, which by the 23d, p. m., had extended its influence eastward into Louisiana and northeastward toward Virginia. On the 23d, p. m., the upper atmosphere contributed a falling pressure over the middle and south Atlantic States, while the lower atmosphere contributed rain and cloud over these States and the Lake region; this combination was favorable to the formation of a special cyclonic depression, No VII, central in southern Virginia on the 23d, p. m. The central barometric pressure fell steadily until the 25th, a. m., when it was central in southern New Hampshire; high winds prevailed on the 24th on the New England coast. The cyclonic system was partly broken up on the 25th as the center moved eastward and disappeared south of Nova Scotia.

In connection with low area No. VII signals for high winds were ordered as follows: 24th, 10.30 p. m., storm northeast from Narragansett section to Portland; 25th, 10.30 a. m., storm northeast at Eastport; 25th, 8.40 a. m., cautionary southwest Woods Holl section.

VIII.—The quiet condition of the atmosphere during the first part of May over the United States was not seriously disturbed until the 25th, on which day a trough of low pressure suddenly extended from British Columbia southward to the Gulf of California, and heavy southerly winds, with rain, prevailed in northern California. This great change can only be attributed to a sudden change in the movements and pressures in the layer of air high above the western slope of the Rocky Mountains which, apparently, suddenly acquired a

rapid motion from the southeast, and the area of rain moved northward, reaching Montana by the 26th, p. m., at which time the lowest pressure was central in British Columbia. This depression moved slowly eastward and disappeared on the 29th, a. m., in Saskatchewan.

IX and X.—On the 26th, a. m., a slight depression is charted in South Dakota as an eastern branch of the large area connected with No. VIII. This depression moved eastward into Iowa, where it really constituted a trough between the cold northerly and warm southerly winds. On the 27th it moved further east over Lake Huron, preserving the same trough-like character; this original trough disappeared on the 28th in Ontario, but a second trough, No. X, formed on the 28th, a. m., in West Virginia, which moved northeastward over New Jersey and disappeared in eastern Massachusetts on the 29th, a. m.

In connection with low area No. IX, signals for high winds were ordered as follows: 27th, 10 a. m., cautionary northwest at Chicago, Grand Haven, and Mackinaw sections; 27th, 5 p. m., cautionary northwest at Sault Ste. Marie; 11.10 p. m., cautionary northwest at Alpena.

XI.—On the 30th pressure again fell, as in the previous case, from the Gulf of California to British Columbia, but was lowest in Idaho, so that neither wind nor rain on the California coast was notably severe. By the 31st, p. m., a distinct narrow trough of low pressure extended from Yuma to Edmonton, the further history of which belongs to the month of June.

XII.—On the 30th pressure rose over the Lake region but fell in the south and middle Atlantic States, so that by the 30th, p. m., a moderate depression was near Lynchburg; this moved slowly northeastward over New Jersey and Cape Cod, with steadily increasing winds and falling pressure, constituting a severe local storm, whose subsequent history belongs to June.

In connection with low area No. XII, signals for high winds were ordered as follows: 31st, 9.40 a. m., storm northeast from Sandy Hook to Boston and section; 31st, 11.10 a. m., storm at Portland, Me.; 31st, 10.50 p. m., storm northeast at Eastport.

## NORTH ATLANTIC METEOROLOGY.

[Pressure in inches and millimeters; wind-force by Beaufort scale.]

The normal barometric pressure for May over the North Atlantic Ocean, as deduced from international simultaneous meteorological observations taken at Greenwich noon, and not reduced to standard gravity, is highest, 30.20 to 30.22 (767 to 768), in a small oval between N. 26° and N. 35°, and W. 27° and W. 34°; a corresponding region of high pressure exists over the Pacific Ocean in N. 20° to N. 40°, and west of W. 130°. The region of lowest pressure, 29.85 (758), over the North Atlantic Ocean is an oval that includes Iceland, Jan Mayen, and Bären Island and touches North Cape on the east and Greenland on the west; the lowest pressure in the Pacific Ocean, 29.70 (755), extends from Kamchatka eastward through the Aleutian Islands. The isobars of the Northern Hemisphere for May show a decided diminution in the pressure over the northern portion of North America up to the Arctic circle and beyond.

As compared with April the normal pressures in May are lower throughout the United States, the Hudson Bay region, northern Greenland, the whole of Asia, and the western portion of the Pacific; the pressures are higher over the Atlantic Ocean and Europe, as also over the central Pacific and eastward into the British Possessions. There is evidently a continued tendency to the formation of a trough of low pressure

extending from the north pole southward over Hudson Bay and southwest over the Gulf of California, dividing the areas of rising pressure over the Atlantic and Pacific.

The normal zone of maximum frequency of paths of storm centers passes from China, at N. 30°, northeast through Japan and Bering Sea to N. 56°, W. 156°; thence southeast into Utah and Colorado at N. 42°, W. 100°; thence northeast over the Lake region and Newfoundland, the Atlantic, and either north of Scotland to the coast of Norway at N. 60°, E. 10°, or else southeastward into Europe, reaching N. 45°, E. 20°. The maximum number of storm centers passing over any quadrilateral of 5° in latitude and longitude is 3.4 annually in the region between the Lakes and the mouth of the St. Lawrence; a corresponding maximum of 2.2 occurs in the neighborhood of Scotland, and one of 2.3 in southern Japan.

The normal rate of progress of storm centers during May is 25 miles per hour in the United States, 16 miles over the Atlantic, 18 miles in Europe, 24 miles in the China and Japan seas, and 20 miles in Bering Sea.

In general it will be noticed that the storms that continue as cyclonic whirls for any length of time in the Northern Hemisphere have areas of predominating high pressure on

their western side, and that in fact they generally originate when such areas of high pressure send a steady flow of air southward into extensive regions where the pressure is a little below the normal; in such cases the influence of the rotation of the earth is favorable to the formation and continuation of cyclonic whirls; the same may be said of areas of high pressure that push northward on the eastern end of a general depression. On the other hand when a high pressure on the north is pushing south and west at the eastern end of a general depression, the conditions are not favorable for the perpetuation and development of cyclonic whirls. Inasmuch as these high areas represent overflowing and descending air from the upper layers of the general circulation of the atmosphere, therefore, the paths of the centers of cyclones represent in general the region to which this general circulation extends; thus, over the Pacific Ocean where the general circulation is more important than the continental circulation, these paths are furthest from the equator; over the North Atlantic they extend rather less toward the north, but over North America, and especially over Asia, they extend still less away from the equator, showing that the so-called general circulation of the Northern Hemisphere, or the ideal circulation that would prevail over a globe of uniform ocean, is almost entirely broken up. This, which is partly true in the winter time, is peculiarly so as the summer advances until in July the circulation of the air and the paths of the storms are grouped about the continents and the oceans more decidedly than about the north pole and the equator.

#### NORTH ATLANTIC STORMS.

The following paragraphs give some account of the areas of low pressure and strong winds on the Atlantic Ocean during May, 1894. Daily charts are compiled at the Weather Bureau showing the atmospheric conditions over the United States, Europe, and the Atlantic Ocean, as nearly as practicable at Greenwich noon, and afford a basis for approximating the locations and paths of the more important areas of high and low pressure.

*A.* This was apparently a continuation of *G* of the North Atlantic series for April; it appears to have passed far north of our reports during April 30 and May 1 and 2, while an area of high pressure, 30.75, was central on the 1st at N. 48°, W. 23°. On the 3d, noon, *A* was central at N. 64°, longitude 0; 4th, noon, N. 59°, W. 4°, and subordinate centers were developing in southern Europe; 5th, noon, N. 57°, E. 12°, with another center in Italy. By this time pressure had also fallen decidedly over the Atlantic and the northern portion of North America, so that by the 6th, noon, *A* had partially filled up and appeared as a minor feature on the eastern side of the great depression that then prevailed between Great Britain, Norway, and Labrador.

*B, C, and D.* On the 1st a depression prevailed over the Rocky Mountain and Lake regions that was probably only a portion of an extensive trough trending northeastward toward Greenland; on the 2d the southern end of this trough was central over Labrador and Baffins Bay, and on the 3d it extended from N. 40°, W. 65°, northeastward toward Iceland; 5th, noon, areas *B* and *A* had apparently joined and by the 6th, noon, the isobar of 29.5 covered the entire area between Sweden on the east and Manitoba on the west. This western extension represented the low area, *C*, that had crossed the Rocky Mountains on the 2d and was identical with low No. III of the U. S. series for May. In the central portion of this extensive trough a new storm whirl, *D*, developed that was central on the 7th, noon, at N. 55°, W. 26°; on the 8th, noon, at N. 58°, W. 20°, and at noon of the 9th, N. 56°, W. 14°; 10th, noon, N. 60°, W. 10°; 11th, noon, N. 60°, W. 8°, after which this disappeared in central Europe. Meanwhile, at the western extremity of this trough, area *C* was, on the 7th,

noon, central near James Bay, and on the 8th, noon, in Labrador, after which it disappeared, probably filling up as it passed over Baffins Bay on the 9th.

*E.* On the 10th a small disturbance apparently began forming about N. 40°, W. 50°; it was central on the 11th at N. 40°, W. 45°; 12th, N. 42°, W. 43°; 13th, N. 44°, W. 42°, at which time it had stretched into an oval extending northwest and southeast and was dissipated by the 14th.

*F.* This was a continuation of low No. IV of the U. S. series, which was central on the Rocky Mountain slope on the 8th, and had by the 11th retired northward to Hudson Bay. Its path was far north of our reports, and it was soon lost in the extensive depression that prevailed over the North Atlantic.

*G.* This letter is given to the depression that developed on the 13th and 14th a little to the west of *E* and while the latter was apparently being dissipated. It was central on 14th, noon, N. 45°, W. 55°; 15th, noon, N. 48°, W. 57°; 16th, noon, N. 48°, W. 60°, after which it disappeared. During this progress northeastward an extensive area of high pressure had descended southwestward over Norway, Sweden, Great Britain, Iceland, and the North Atlantic, so that these regions were, from the 14th to the 17th, covered by this westward extension of the Siberian area of high pressure, while a corresponding area of low pressure advanced eastward over the United States and British America, which is described as No. V of the U. S. series.

*H.* On the 16th, while the preceding area, *G*, was being broken up as a distinct whirl over the Gulf of St. Lawrence, another subsidiary whirl was developing far to the southward, and by the 17th, noon, this was central N. 43°, W. 54°; it moved slowly, with diminishing winds and rising barometer, and disappeared on the 19th at N. 45°, W. 46°.

*I.* While the preceding depression, *H*, was filling up and disappearing on the 19th, another whirl and low pressure developed to the southward, and was central on the 20th at N. 38°, W. 45°. This was the third extensive whirl that had been formed at the southwestern border of the great area of high pressure that had slowly advanced west and south over the North Atlantic Ocean. On the 19th, noon, this high pressure, 30.55, or more, was central between Great Britain and Iceland, with northeast winds over the Atlantic north of N. 40° and east of W. 40°. On the 20th the highest pressure had apparently moved still further westward. These conditions favored the development of the cyclonic area, *I*, which moved slowly northeastward and was central on the 21st, noon, at N. 41°, W. 45°, while in its neighborhood winds of force 10, 11, and 12, with very low pressures, were reported by the steamers *Fürst Bismarck*, *America*, *Delano*, and *Dania*. On the 22d, noon, the area of low pressure had enlarged considerably and apparently included three subsidiary centers within 2° of the general center at N. 44°, W. 45°, and reports of low barometers, or high winds, were received from the steamers *Massachusetts*, *Fürst Bismarck*, *Delano*, and *Borghese*. The high pressure on the east of *I* now moved rapidly south while the center of *I* moved rapidly north, and on the 23d, noon, was at N. 51°, W. 41°; 24th, noon, N. 52°, W. 40°, after which this whirl disappeared, although a general and extensive area of low pressure still remained.

*J.* On the 10th pressure began to fall from British Columbia to the Gulf of California, and by the 14th, noon, a large area of low pressure was central in Montana and Idaho, which was No. V of the U. S. series. By the 17th, noon, this was central in Minnesota, and by the 18th over the lower Lake region, while an extensive area of high pressure had descended over the Arctic regions into Manitoba in the west and Great Britain in the east; on the southern side of this area the cyclonic lows *G*, *H*, and *I* had already been formed and dissipated, but when, on the 19th, the center of *J*, or the western

end of the whole depression, had advanced eastward to the Atlantic coast of Virginia the conditions that were favorable for its further special development were antagonized by the rapid movement westward toward Newfoundland and Labrador of the high pressure that was then prevailing over Great Britain. On the 20th, noon, the lowest pressure was still central in Virginia and the high pressure over Manitoba was still central in that region, while, on the other hand, pressure had rapidly risen, with northeast winds, over New England and the Maritime Provinces. To this latter feature we must attribute the breaking up of *J*, which had disappeared on the 21st, noon, and also the development of *I*, as above narrated.

*K*. This appeared as a feeble depression on the 24th, noon, on the middle Atlantic coast, and was identical with No. VIII, U. S. series, having apparently originated in Virginia during the preceding twelve hours. This area moved northeastward, reaching the Bay of Fundy on the 26th, noon; it then passed over the Gulf of St. Lawrence, and on the 29th, noon, was at N. 52°, W. 48°. After this the cyclonic whirl rapidly increased in severity, and it was central as a severe storm on the 30th at N. 48°, W. 25°, while the low pressure that was then over Europe apparently extended westward toward it. On the 31st this storm was central at about N. 48°, W. 29°.

*L*. This letter is assigned to the extensive depression that prevailed over the Mediterranean on the 17th, while high pressure was reaching south and west over northern Europe and the Atlantic. Numerous local depressions apparently developed over southern Europe on the 16th, 17th, and 18th, while the dividing line, 29.9, between high and low pressure extended rapidly north and west, until, on the 20th and 21st, the low pressure prevailed over all Europe, except Great Britain. From the 22d to the 25th the high pressure on the north gradually extended over Sweden, Germany, and Russia, but by the 26th an extensive whirl and low pressure had developed over central Europe, and so continued during the 27th and 28th, after which it broke up and had disappeared by the 31st.

#### OCEAN FOG FOR MAY, 1894.

The limits of fog belts for May, 1894, as determined from reports of shipmasters, are shown on Chart I by dotted

shading. More than the usual amount of fog was encountered in this month. Near the Grand Banks of Newfoundland fog was reported on 25 days; between the fifty-fifth and sixty-fifth meridians on 20 days; and west of the sixty-fifth meridian on 22 days. Compared with the corresponding month of the last six years, the dates of occurrence of fog near the Grand Banks numbered 8 more than usual; between the fifty-fifth and sixty-fifth meridians, 7 more than usual; and west of the sixty-fifth meridian, 6 more than usual.

#### OCEAN ICE IN MAY, 1894.

The following table shows the southern and eastern limits of the regions within which icebergs or field ice were reported in May for each year:

Southern limit.			Eastern limit.		
Month.	Lat. N.	Long. W.	Month.	Lat. N.	Long. W.
May, 1883	40 30	47 00	May, 1883	45 40	45 12
May, 1884	41 30	47 30	May, 1884	43 30	44 50
May, 1885	40 50	48 15	May, 1885	42 30	40 10
May, 1886	41 36	51 30	May, 1886	48 55	46 13
May, 1887	39 38	46 00	May, 1887	39 38	46 00
May, 1888	41 00	46 00	May, 1888	41 00	46 00
May, 1889	43 07	55 47	May, 1889	49 46	36 48
May, 1890	40 50	50 28	May, 1890	44 12	36 25
May, 1891	40 49	49 07	May, 1891*	48 00	45 00
May, 1892	42 14	51 20	May, 1892	45 05	41 14
May, 1893	41 05	55 55	May, 1893	47 02	42 16
May, 1894	40 34	48 35	May, 1894	43 31	43 37
Mean	41 12	49 54	Mean	45 02	42 44

\* On the 7th three small pieces of ice were reported in N. 49° 03', W. 33° 40'.

The limits of the region within which icebergs or field ice were reported for May, 1894, are shown on Chart I by crosses. The southernmost ice reported, a large berg observed on the 25th in the position given, was about one-half of a degree farther south than the average southern limit of ice for May, and the easternmost ice reported, a medium sized berg, noted on the 1st in the position given in the table, was over one degree east of the average eastern limit of ice for the month. Ice was reported in great quantities over the southern and northern parts of the Banks of Newfoundland. Two bergs each about 3,000 feet long were reported south of the Grand Banks on the 18th.

### TEMPERATURE OF THE AIR.

[In degrees Fahrenheit.]

The distribution of the monthly mean temperature of the air over the United States and Canada is shown by the dotted isotherms on Chart II; the lines are drawn over the high irregular surface of the Rocky Mountain plateau, although the temperatures have not been reduced to sea level, and the isotherms, therefore, relate to the average surface of the country occupied by our observers; such isotherms are controlled largely by the local topography, and should be drawn and studied in connection with a contour map.

#### NORMAL TEMPERATURE.

In Table II, for voluntary observers, the mean temperature is given for each station, but in Table I, for the regular stations of the Weather Bureau, both the mean temperatures and the departures from the normal are given for the current month. In the latter table the stations are grouped by geographical districts, for each of which is given the average temperature and departure from the normal; the normal for any district or station may be found by adding the departures to the current average when the latter is below the normal and by subtracting when it is above.

#### MONTHLY MEAN TEMPERATURE.

For the regular stations of the Weather Bureau the monthly mean temperature is the simple mean of all the daily maxima and minima; for voluntary stations a variety of methods of computation is necessarily allowed, as shown by the notes appended to Table II.

During May, 1894, the highest mean temperatures were: Southeastern California, 90; southern Arizona, 88; and southern Texas, 82. The lowest temperatures were: at Canadian stations, 41 at Anticosti Island, and 44 at Sidney and White River; at United States stations: 46.7 at Eastport, 46.6 at Marquette, 47.7 at Sault Ste. Marie, and 48.1 at Tatoosh Island. The temperature averaged 32 at no point within the limits of our daily map, except on the peaks of the mountains.

#### DEPARTURES FROM NORMAL TEMPERATURE FOR MAY, 1894.

As compared with the normal for May the temperatures were decidedly in excess over the Rocky Mountain region and its eastern slopes, as also on the middle Atlantic coast, but were deficient in the central portion of the Lake region, Ohio Valley, and Tennessee, as also in the Pacific States. The